

GLAST Science Analysis Software

Simulation and Reconstruction Status for DC1

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(for the Sim/Recon Gang)
GLAST Collaboration Meeting
September 15-17, 2003
Rome, Italy





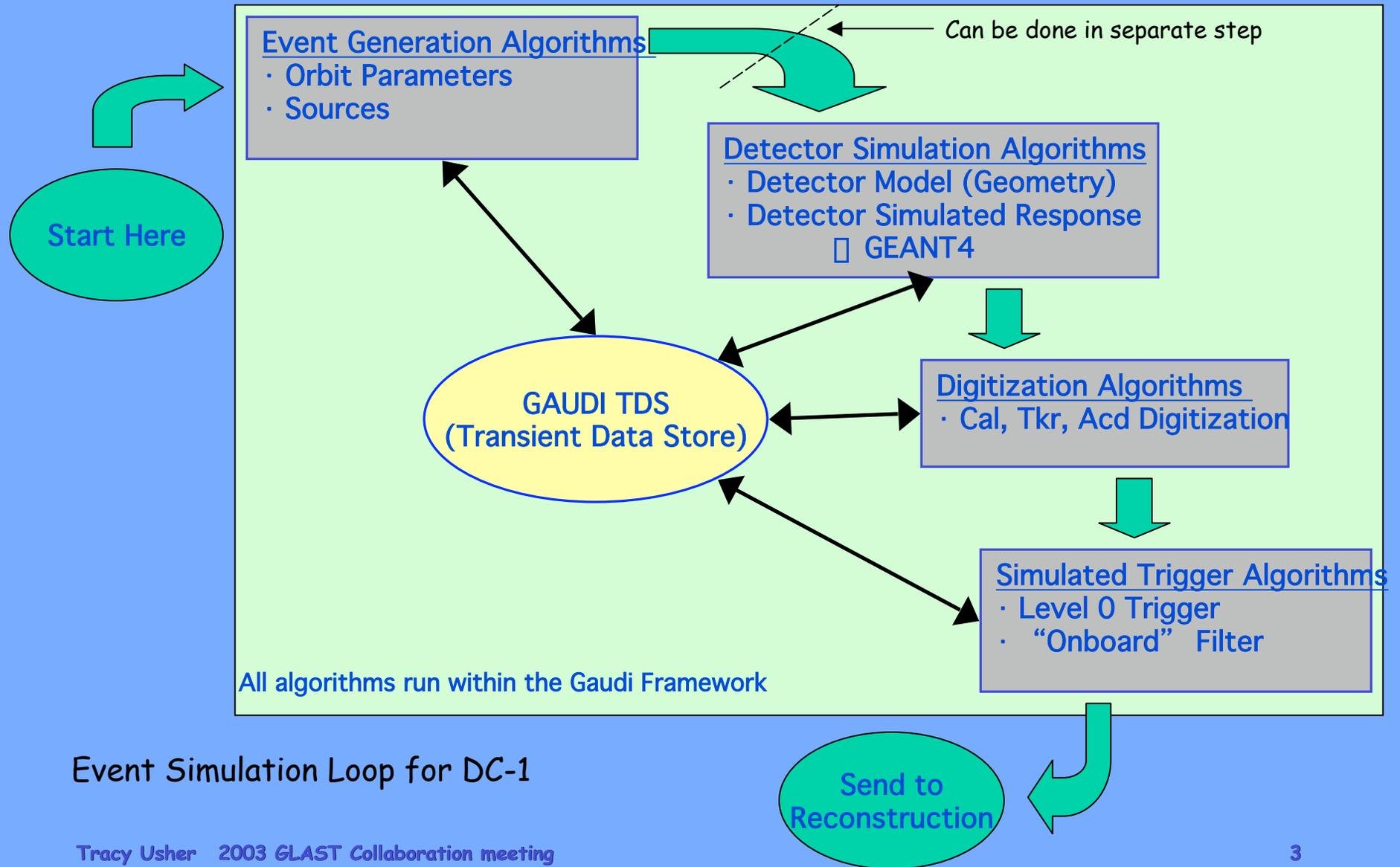
Outline

Goal: Overview of Sim/Recon to be used for DC-1

- **Simulation**
 - Event Generation / Sources
 - Simulation Framework
 - Detector Geometry
 - Geant4
 - Trigger / Onboard Filter
- **Reconstruction**
 - Cal Reconstruction
 - Tkr Reconstruction
 - Acd Reconstruction
 - Event Classification / AnalysisNTuple
- **Processing**
 - Strategy
 - Implementation
- **Schedule**



Simulation: Overview

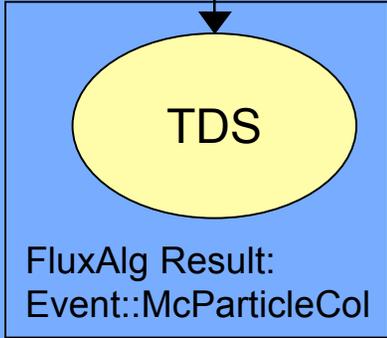
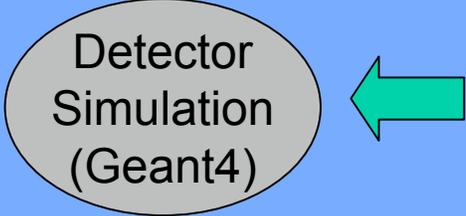
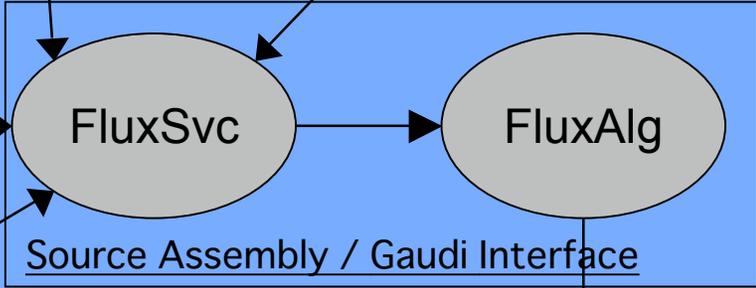
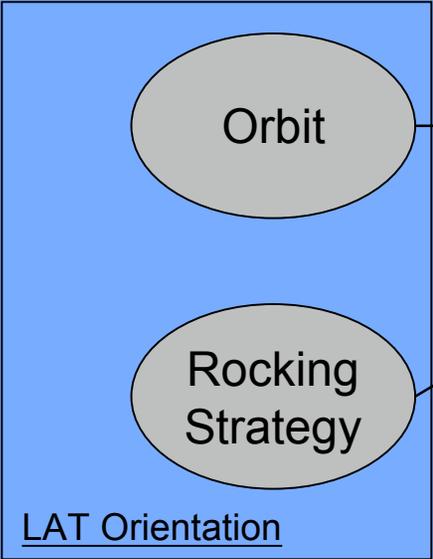
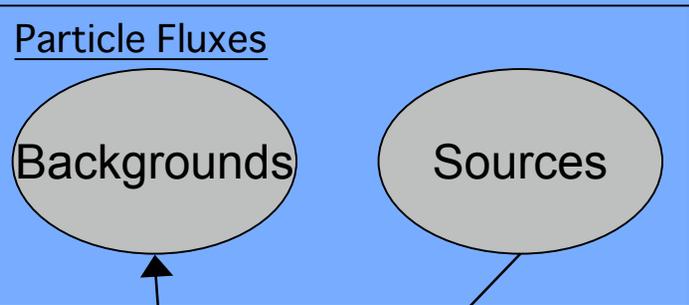




Simulation: Event Generation

Sources Notes:

- New CRflux package to model cosmic ray background (from Tsunefumi Mizuno)
- New MapFlux package to model diffuse galactic background (from Sean Robinson)



Strategy to Simulate Single Orbit Day for DC-1



Simulation: Detector Geometry

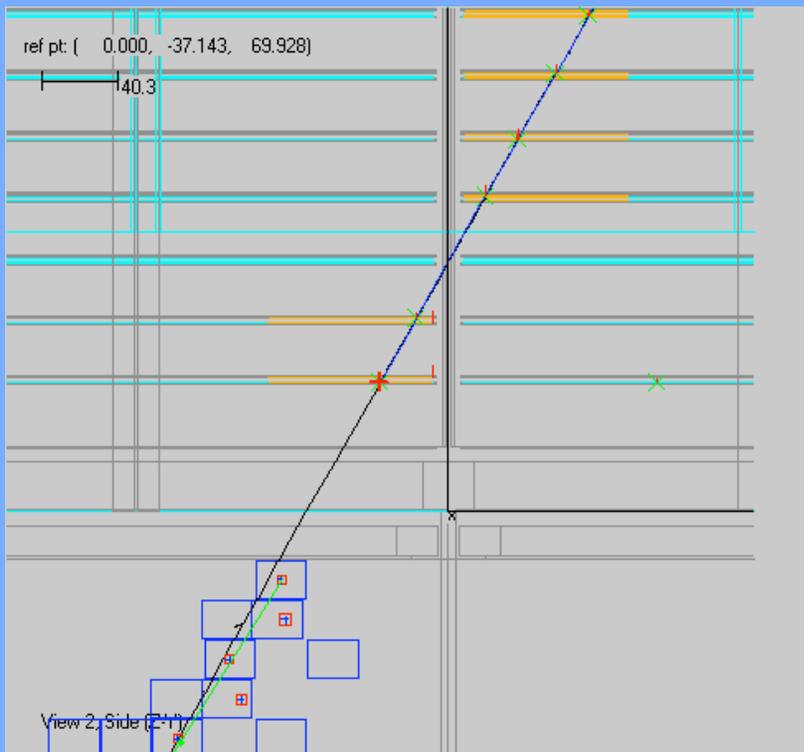
- Gleam uses the same geometry database for simulation and reconstruction.
 - Encoded in xml
 - Simulation builds its GEANT4 geometry using detModel
 - Reconstruction derives necessary positions, dimensions and materials directly from the xml database.
- The Data Challenge prompted reviews of the entire geometry
 - TKR, CAL, ACD
 - NAD (Not A Detector)
- Two "Passes"
 - Get the positions (and dimensions) right
 - Get the material right
- Several problems found / fixed
 - Basically, two categories:
 - Changes since geometry first "captured"
 - Mistakes in encoding into xml
 - While not completely negligible, these changes and corrections are expected to have only a minor effect on the results of our simulations.
- At this point, most of the modifications have been made.
 - The remainder will be made before the "real" DC-1 runs.



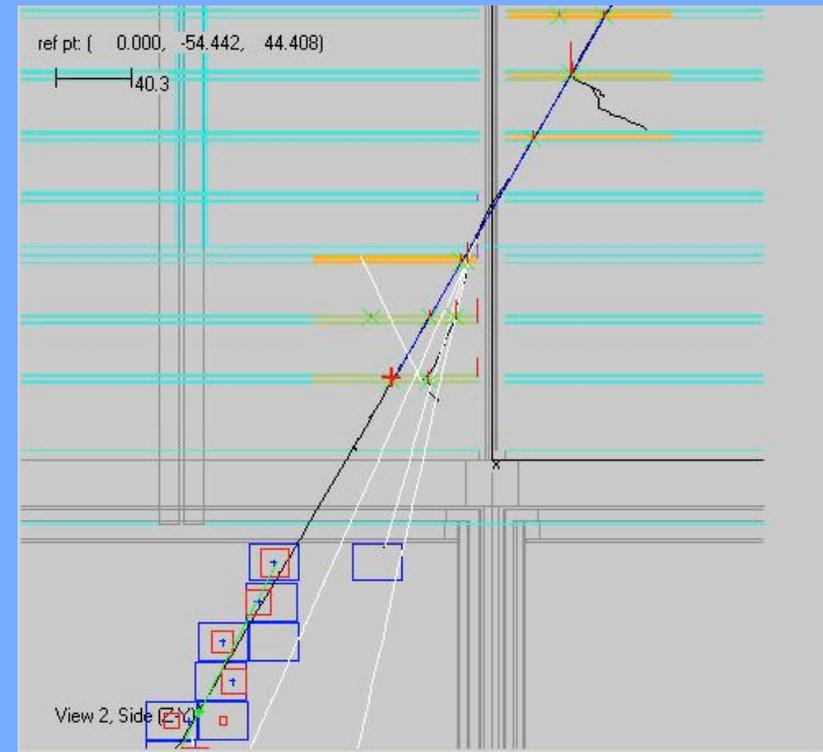
Simulation: Detector Geometry

Cross Checking the Tracker Positions

- Example of position problem: Tracker was found to be ~15 mm too high above the grid.
- Noticeable effect when projecting tracks into the Cal



Previous Gleam



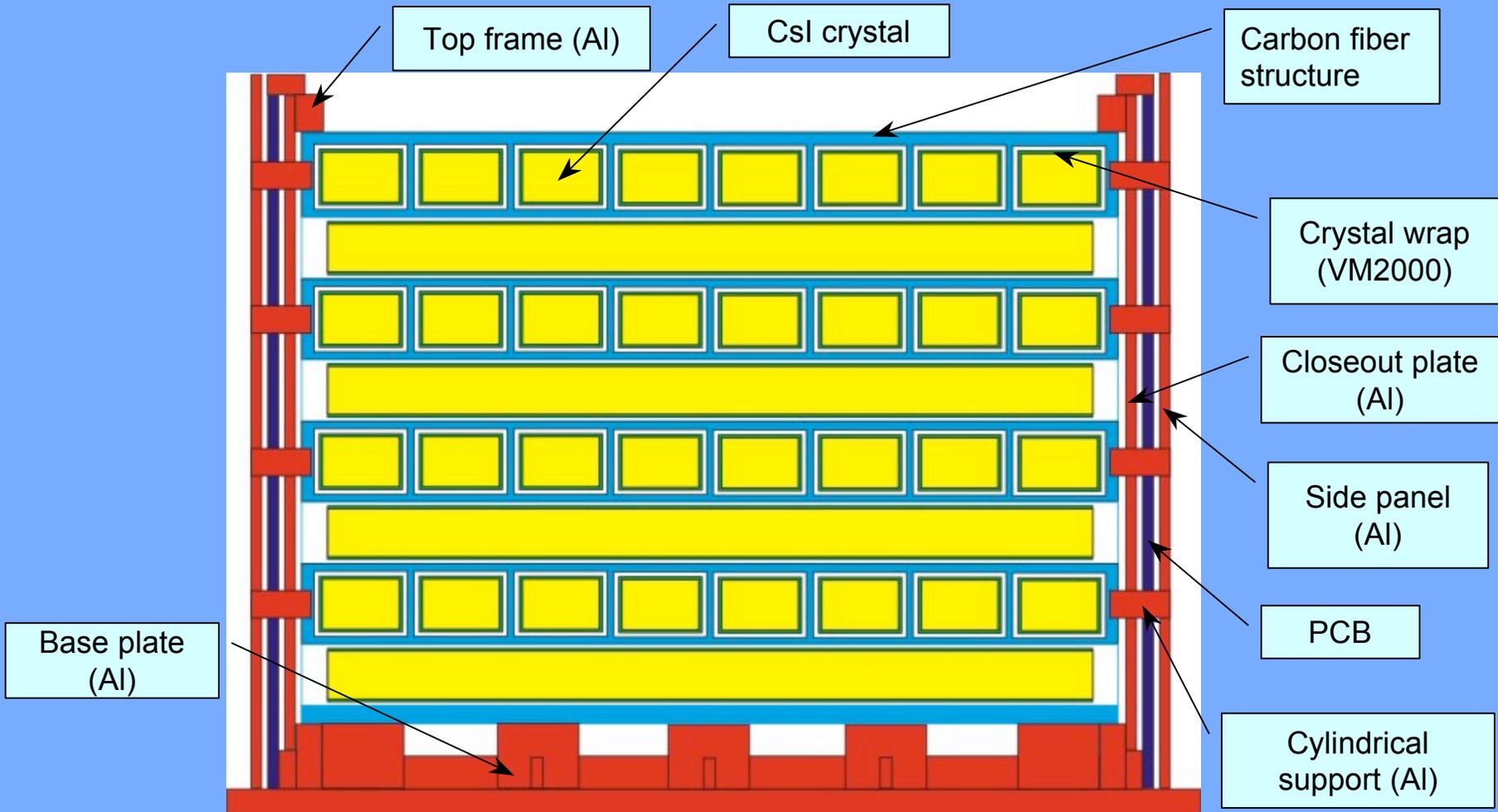
Latest Gleam



Simulation: Detector Geometry

CAL geometry overview

(not to scale - only 8 crystals per layer shown)

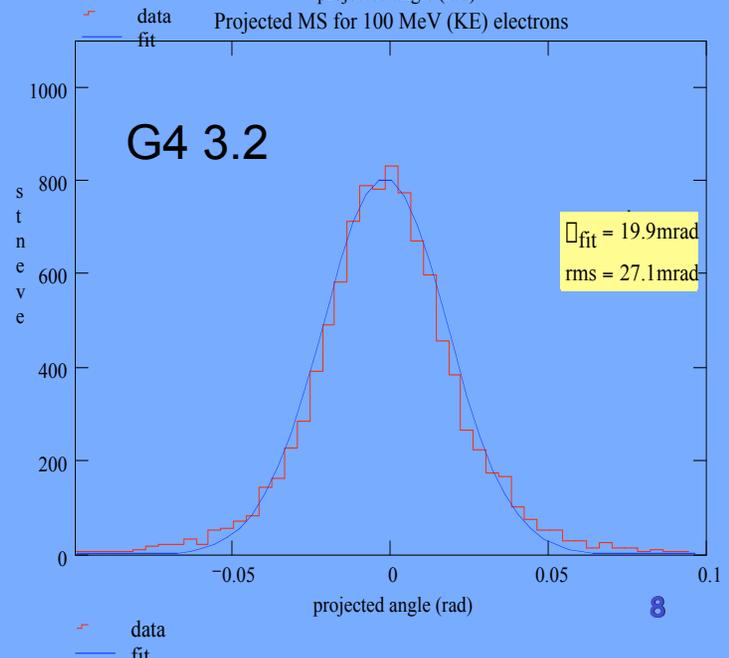
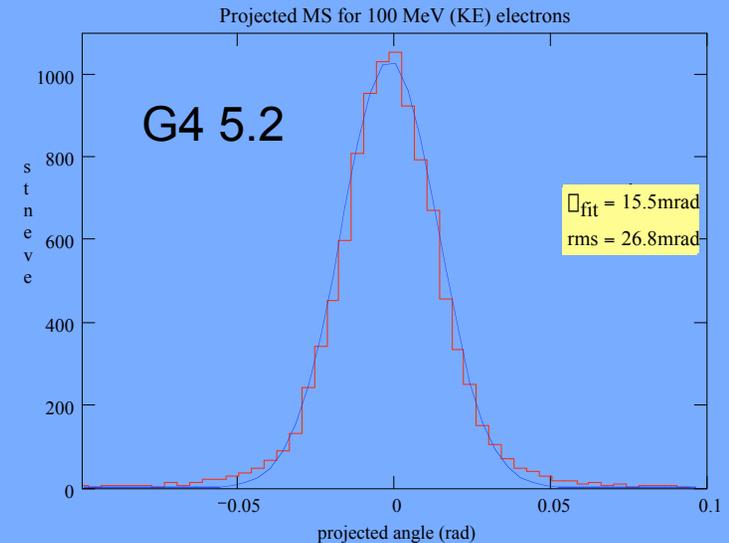




Simulation: Geant4 Status

Multiple Scattering Problem and DC-1 Solution

- Upgraded to Geant4 5.0 (from 3.2) in Feb 2003
 - Then to Geant4 5.1 in May 2003
- Motivation:
 - Newest version with many updates
 - In particular really wanted ability to set energy range cutoff values by "region"
- But...
 - Not backward compatible, many changes to the "RunManager" interface, etc.
- Problem (!!)
 - Discovered that a significant change, ~20% had happened from 3.2 to 5.1 in the multiple scattering widths (by getting too "good" answers!)
 - Example: 100 MeV e⁻ incident on 105 μm of W
- Solution for DC-1
 - Upgrade G4 v3.2 MS code interface to v5.2
 - Get "region" range cut off and expected MS
 - Include ability to switch between versions





Simulation: Geant4 Status

Preventing the Problem for Future GLAST G4 Upgrades

- **GEANT4 Side**
 - Developing a validation framework
 - Providing GLAST support for interfacing to this validation framework
 - Tatsumi Koi (at SLAC)
- **GLAST Side**
 - "Trust but verify"
 - Assume GLAST must check G4
 - Develop test suite to allow validation of all physics processes
 - Processes to test →
 - Recreate validation done by Tune, et al
 - Automated comparison of new G4 releases to previous to look for changes
 - Run validation test suite before switching to any new version of Geant4
 - Compare to data whenever possible
 - Work well under way
 - See comparisons next page
- **Both Sides**
 - Liaisons on both sides
 - GLAST will have access to prerelease code updates for testing
 - e.g. will have access to newest MS code for testing by end of October

Processes Validation List

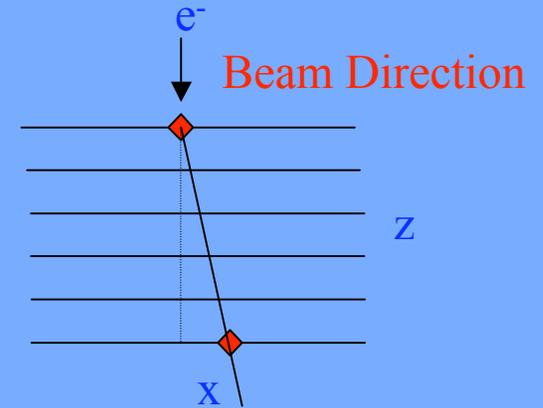
- **Multiple Scattering**
 - Angular distribution, Energy Dependence
- **Photon processes: Photoelectric, Compton Scattering and Pair Production**
- **Cross Section, Angular and Energy Distribution**
- **Charged particles processes**
- **Ionization**
 - Landau and Bethe Bloch
 - Range, Straggling, Stopping Power
- **Bremsstrahlung**
 - Cross Section, Angular and Energy Distribution
- **Delta Ray production**
 - Energy distribution, Multiplicity
- **Positron Annihilation**
- **EM shower development**
- **Muon-nucleus interactions**
- **Neutron interactions**
- **HE hadron-nucleus interactions**
- **Nucleus-nucleus elastic scattering**
- **Hadronic showers in Csl**
- **Radioactive decay**



Simulation: Geant4 Status

Multiple Scattering Validation with data

- Electron test beam at Frascati for AGILE, (2003) [F. Longo]
- Geometry:
 - 6 planes with 300 μm of W
 - Inter-plane distance 1.6 cm
- Analysis:
 - Require single cluster on the 1st and 6th plane
 - plot x/z



Energy (MeV)	Data: x/z distribution	Fit sigma deflection (mrad)			
		Expt	G3	G4 5.2	G4 3.2
79		109	104	81	101
650		14.6	13.3	8.4	14.2

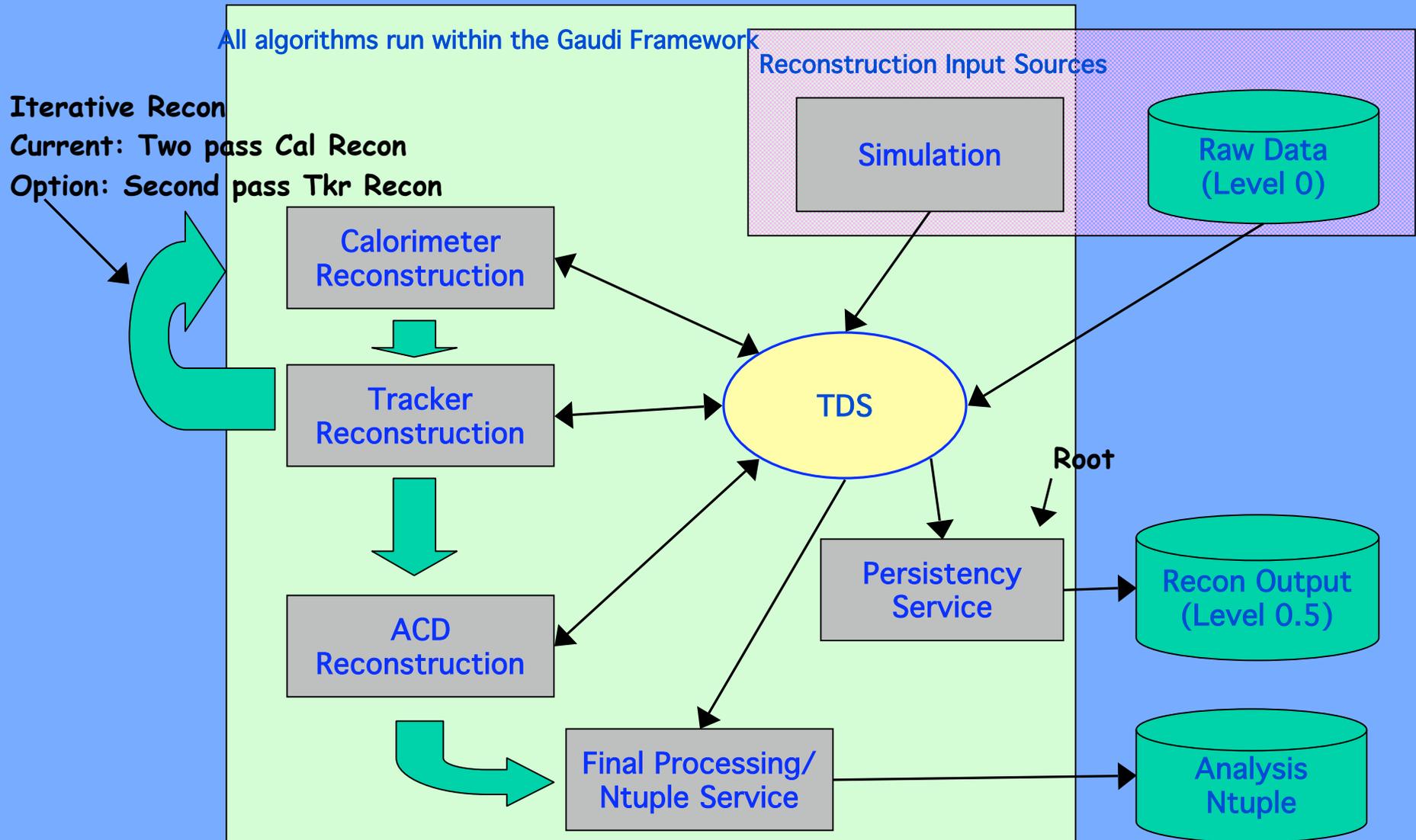


Simulation: Trigger and Onboard Filter

- **Trigger**
 - Did something interesting happen in the LAT?
 - **Basic Elements (in simulation)**
 - Tracker 3-in-a-row
 - Cal Hi, Cal Lo
 - Etc.
 - **Keep Everything that passes?**
 - 5 kHz rate
 - Too much data (?)
 - 10's of TB!
 - **Filter Triggered Events**
 - Do we want to keep this event?
 - **Onboard Filter**
 - Use JJ's Flight Software Filter Code in simulation
 - See Steve's talk from yesterday
 - Code ported to the simulation
 - Some diagnostics available
 - **Keep only events passing filter?**
 - <30 Hz rate
 - 10's of GB
- DC-1 Simulation will use the Onboard Filter "as is" to reject possible background events.**



Reconstruction: Overview





Reconstruction: CalRecon

- Pass 1 of CalRecon

- Cal Digi's input
- Apply corrections
 - Gains
 - Pedestals
- Reconstruction
 - Sums over all layers
 - Initial position/direction

- Pass 1 output:

- Total energy estimate
- Cluster centroid position
- Cluster direction

DC-1 Cal Recon will use two pass CalRecon with the "Shower Profile Method."

- Pass 2 of CalRecon

- Input
 - Cal Digs (again)
 - Gamma direction from TkrRecon
- Improved energy determination
 - Primarily Leakage correction
 - "Shower Profile Model" developed by Bill Atwood
 - "Last Layer correlations" developed by Berrie Giebels
 - » Lots of work currently underway on this algorithm but may not be quite ready for DC-1

- Pass 2 Output

- Corrected energy
- Cluster centroid position
- Cluster direction



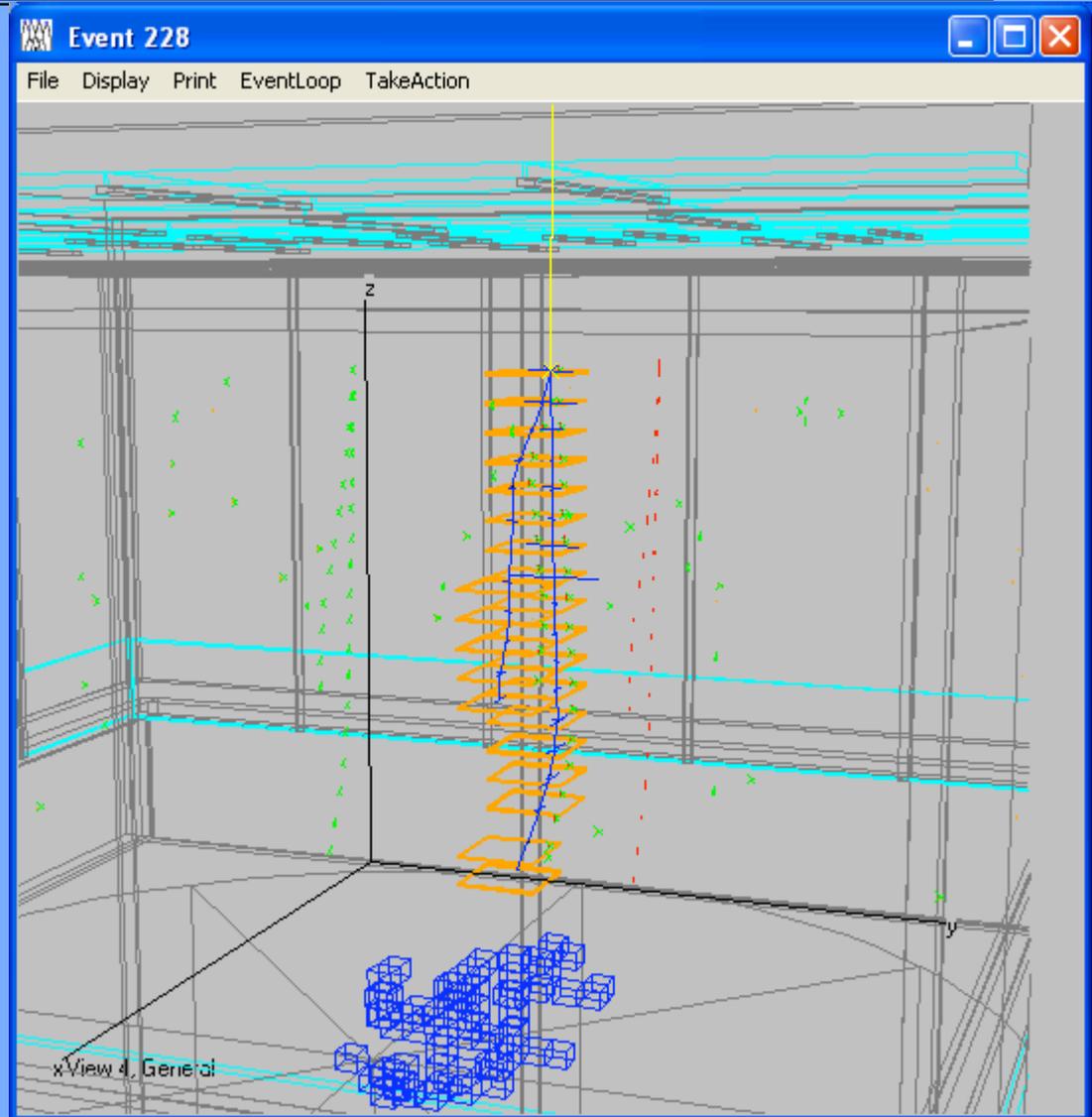
Reconstruction: TkrRecon

Tracking proceeds in four steps:

- Clustering
- Pattern Recognition
 - Use "Combo" Pattern Rec
 - Brute Force approach
 - By far best understood approach
 - Most important step!
- Track Fitting
 - Kalman Filter Track Fit
 - Need good Energy from Cal/Tkr
- Vertex Finding/Fitting
 - Straightforward
 - Combine two approaches in one
- **Reconstruction for DC-1**

Iterative TkrRecon

- Re-runs Track Fit and Vertexing
- Need improved energy from Cal
 - **Not used for DC-1 (?)**



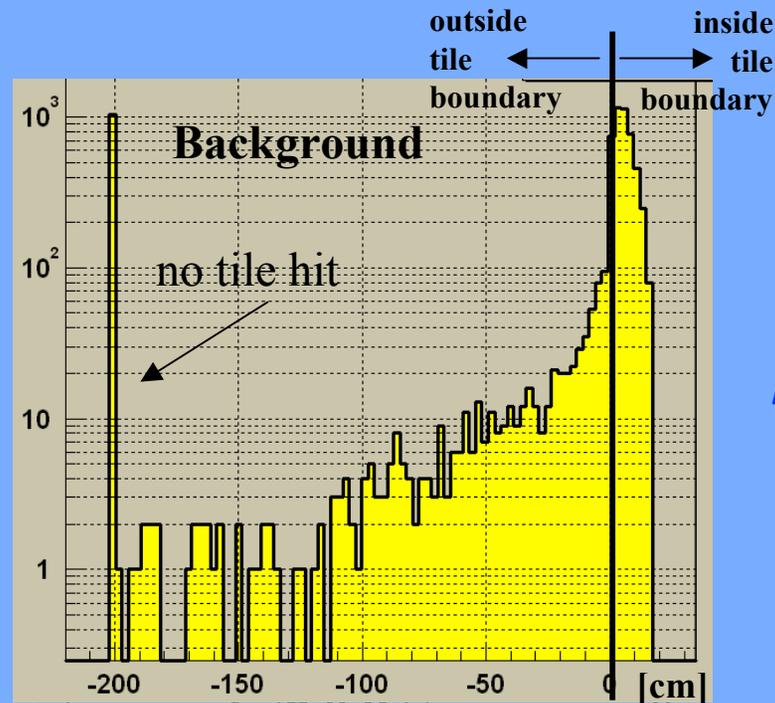


Reconstruction: ACDRecon

Primary outputs (both originally designed by Bill Atwood):

1) Active Distance:

measures distance from edge (done once for entire ACD, and by region)



ACD_Act_Dist

ACD_DOCA

2) **Distance of Closest Approach (DOCA):** measure distance from the center of a tile. Done also for different regions of the ACD, since tile size varies.

Recon also provides: energy deposition estimate and counts of tiles above threshold by region. (slide courtesy of Heather Kelly)

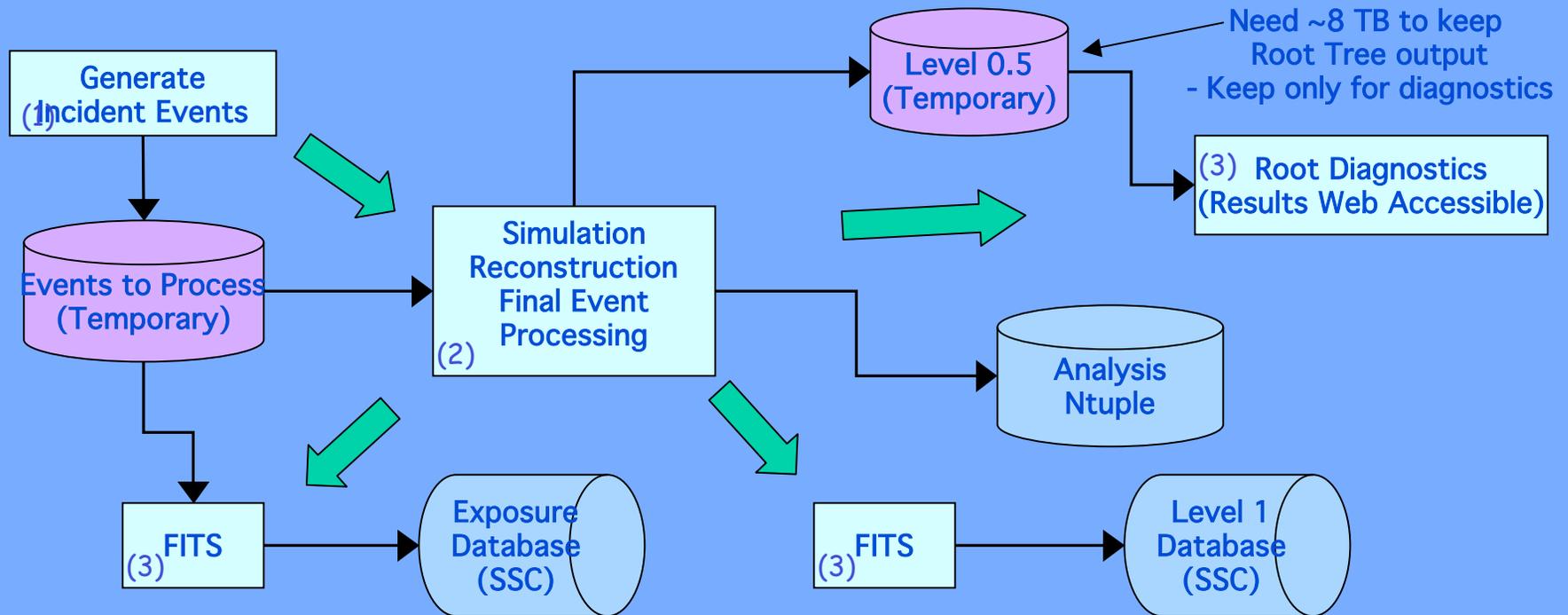


Reconstruction: Post-Recon Processing

- Final Event Processing - meritAlg
 - Construct output ntuple
 - Best Gamma Energy, pointing, etc.
 - Calculate useful quantities for downstream analyses
 - e.g. TkrTwrEdge: The average distance of the track from the "edge" of each tray, weighted by radiation lengths traversed.
 - Over 200 quantities output, explanation of all of them found at:
http://www-glast.slac.stanford.edu/software/DataChallenges/DC1/AnalysisNtuple_doc.htm
 - Event Classification
 - Event type and quality
 - Separate signal from background
 - Via classification trees
 - Classification trees for gammas, background
 - Details of all of this in Bill's talk
- FITS file output 
 - Level 1 database input
 - Everything needed is available at the completion of meritAlg
 - Work on conversion in progress



Processing: Strategy for DC-1



DC1 Goal: One day's input to the onboard filter

- <5 kHz Trigger rate
- ~1.75 CPU sec/event processing time

Will need:

- 1250 CPU-weeks for ~400 M events
- ~ 50 GB output disk space

Tracy Usher, 2003 GLAST Collaboration meeting

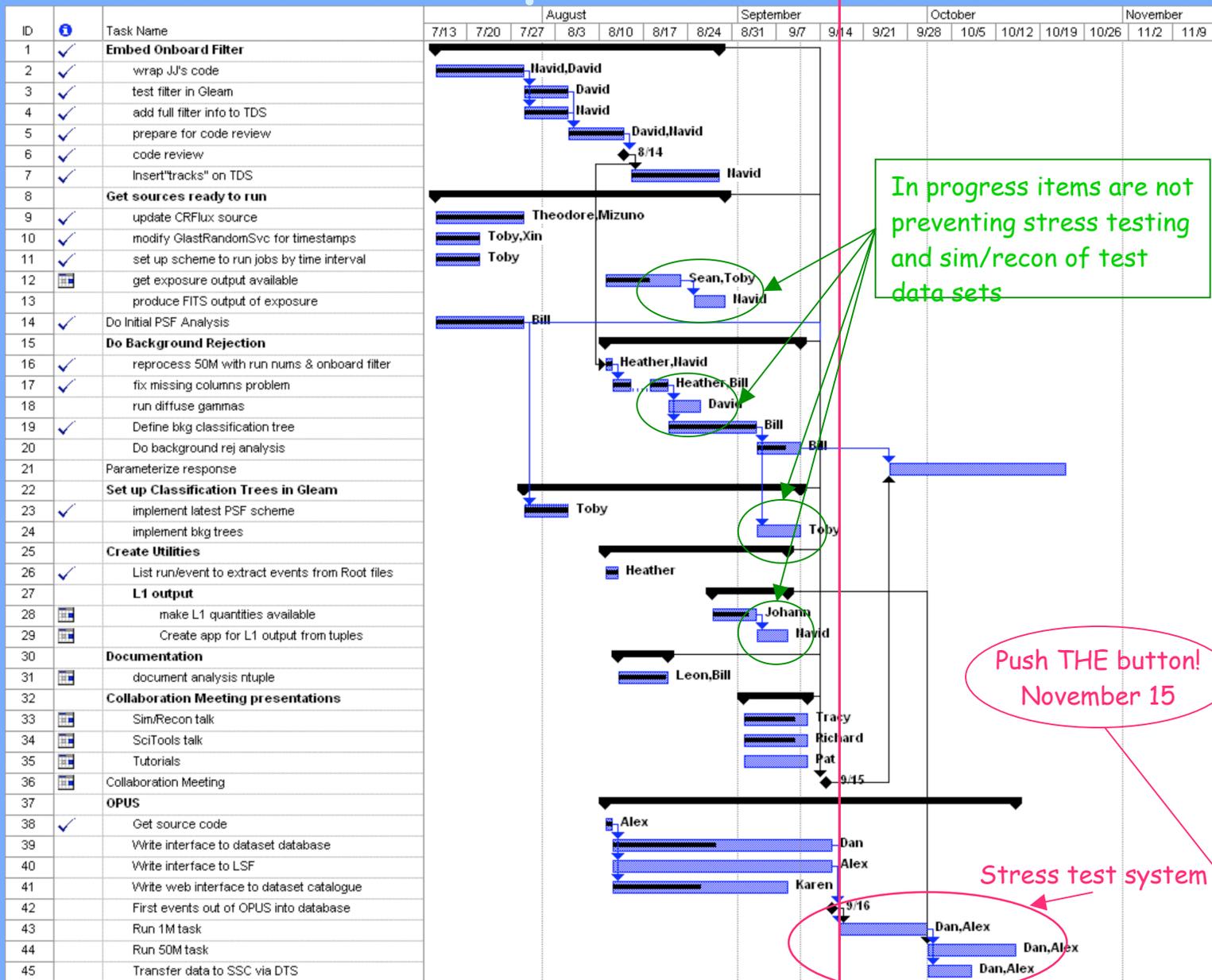
No Level 0.5 output kept

Strategy:

- Break into 86,400 1 orbit-second jobs
- Break each job into 3 major pieces
 - 1) Incident event generation
 - 2) Event simulation and reconstruction
 - 3) FITS Output / diagnostics
- Processing controlled by OPUS



DC1 Prep Schedule



In progress items are not preventing stress testing and sim/recon of test data sets

Push THE button! November 15

Stress test system

Today!